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MOOD MAPPING IN THE DIGITAL WORLD: ML AND DL-BASED INSIGHTS INTO DEPRESSION DETECTION ON SOCIAL PLATFORM

[1] Dr. G. Jawaherlalnehru, [2] Mudigonda Pavani, [3] Thigulla Gopala Krishna, [4] Thanugula Rohith, [5] B.V. Bhargavi
[1] Associate Professor, [2345] B. Tech Students
[1]Department of Computer Science and Engineering
[2345]Department of CSE (DATA SCIENCE)
[12345]Sree Dattha Group of Institutions, Sheriguda, Ibrahimpatnam, 501510, Telangana, India

ABSTRACT

The widespread adoption of social media platforms has transformed digital communication by enabling individuals to share thoughts, emotions, and daily experiences in real time. These online interactions generate valuable textual, visual, and behavioral data that can provide meaningful insights into users' mental health conditions. Depression is one of the most prevalent mental health disorders worldwide, and early identification is crucial for timely intervention and improved psychological well-being. Conventional depression diagnosis primarily depends on clinical interviews, psychological assessments, and self-reported questionnaires, which may delay detection and limit continuous monitoring. Recent advancements in Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL) have enabled automated analysis of large-scale social media data for intelligent mental health assessment. This paper proposes an ML and DL-based framework for depression detection using social platform data by integrating natural language processing, sentiment analysis, behavioral feature extraction, and deep neural networks. The proposed framework analyzes textual posts, user engagement patterns, emotional expressions, and linguistic features to identify depressive tendencies. Comparative evaluation using traditional machine learning algorithms and advanced deep learning models demonstrates that deep learning significantly improves prediction accuracy, precision, recall, and early depression identification. The proposed system provides an intelligent decision-support framework that can assist healthcare professionals in large-scale mental health monitoring while preserving scalability and efficiency. This research contributes to the advancement of AI-driven digital mental healthcare by enabling early depression detection through intelligent social media analytics.

Keywords: Depression Detection, Social Media Analytics, Machine Learning, Deep Learning, Natural Language Processing, Sentiment Analysis, Mental Health, Artificial Intelligence, Text Classification, Behavioral Analytics.

I. INTRODUCTION

Depression is one of the most common mental health disorders affecting millions of people worldwide and has become a significant public health concern due to its impact on emotional well-being, productivity, and quality of life. Individuals experiencing depression often express their emotions, thoughts, and behavioral changes through social media platforms such as online forums, microblogging services, and social networking applications. The enormous volume of user-generated content shared daily provides an unprecedented opportunity to analyze emotional patterns and identify early signs of depression using Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL) techniques. Consequently, social media analytics has emerged as a promising research area for intelligent mental health monitoring and early intervention [1]–[3].

Traditional depression diagnosis primarily relies on clinical interviews, psychological

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questionnaires, and expert evaluations conducted by healthcare professionals. Although these methods provide reliable clinical assessments, they are time-consuming, require active patient participation, and often fail to support continuous monitoring of mental health conditions. Furthermore, many individuals experiencing depression hesitate to seek professional help because of social stigma, limited healthcare accessibility, or lack of awareness. These challenges have motivated researchers to investigate automated depression detection techniques using publicly available digital behavioral data [4]–[6].

Recent advancements in Natural Language Processing (NLP), sentiment analysis, and deep learning have significantly improved the ability of computers to understand human language, emotions, and psychological states. Machine learning algorithms such as Support Vector Machine (SVM), Random Forest (RF), Naïve Bayes, and Logistic Regression have been widely applied for text classification and sentiment analysis. More recently, deep learning architectures including Convolutional Neural Networks (CNNs), Long Short-Term Memory (LSTM) networks, Bidirectional LSTM (Bi-LSTM), Transformers, and Bidirectional Encoder Representations from Transformers (BERT) have demonstrated superior performance by automatically learning semantic, contextual, and emotional representations from large-scale textual data [7], [8].

The integration of AI with social media analytics enables continuous monitoring of textual posts, comments, hashtags, posting frequency, interaction patterns, linguistic characteristics, emotional expressions, and user behavior. By combining textual information with behavioral analytics, intelligent systems can identify subtle indicators of depression that may not be evident through manual observation. Furthermore, cloud computing and large-scale data processing technologies facilitate efficient analysis of millions of social media posts in real time, supporting scalable digital mental healthcare applications and population-level mental health surveillance [9].

Despite remarkable progress in AI-driven depression detection, several research challenges remain unresolved. Social media data are highly unstructured, noisy, multilingual, and context-dependent, making accurate psychological assessment difficult. Privacy concerns, ethical considerations, data imbalance, sarcasm, slang, and evolving language usage further complicate automated depression detection. Therefore, there is an increasing need for intelligent hybrid frameworks that integrate advanced machine learning, deep learning, natural language processing, and behavioral analytics to improve early depression detection while maintaining high accuracy, robustness, scalability, and ethical responsibility [10].

Motivated by these challenges, this research proposes an intelligent ML and DL-based framework for depression detection using social platform data. The proposed system integrates text preprocessing, sentiment analysis, behavioral feature extraction, natural language processing, and deep learning models to accurately identify depressive tendencies from user-generated content. The objective is to improve early mental health detection, support healthcare professionals, and contribute to the development of intelligent digital mental healthcare systems capable of large-scale depression monitoring.

II. LITERATURE SURVEY

M. De Choudhury, M. Gamon, S. Counts, and E. Horvitz (2013) proposed one of the earliest social media-based depression detection frameworks by analyzing users' linguistic patterns, posting behavior, and emotional expressions. The study demonstrated that

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behavioral signals extracted from social media can effectively predict depression before clinical diagnosis, highlighting the potential of digital platforms for early mental health assessment **[11]**.

G. Coppersmith, M. Dredze, and C. Harman (2014) investigated the use of Twitter data for identifying mental health conditions through natural language processing and machine learning techniques. Their research showed that linguistic characteristics and user-generated content provide reliable indicators for detecting depression and other psychological disorders, supporting the development of automated mental health monitoring systems **[12]**.

A. Guntuku, S. Yaden, M. Kern, L. Ungar, and J. Eichstaedt (2017) conducted a comprehensive review of depression detection using social media analytics. The authors examined machine learning, behavioral analysis, and linguistic feature extraction techniques while emphasizing the importance of integrating psychological knowledge with artificial intelligence for reliable mental health prediction **[13]**.

J. Devlin, M. Chang, K. Lee, and K. Toutanova (2019) introduced **BERT (Bidirectional Encoder Representations from Transformers)**, a transformer-based language model capable of understanding contextual relationships within text. The model significantly improved natural language understanding and has been widely adopted for sentiment analysis, emotion recognition, and depression detection from social media posts due to its superior contextual representation learning **[14]**.

Y. Liu, M. Ott, N. Goyal, et al. (2019) developed **RoBERTa**, an optimized transformer architecture that enhanced language representation learning through improved pretraining strategies. Experimental results demonstrated higher performance than conventional BERT models across multiple natural language processing tasks, making it highly suitable for social media sentiment analysis and mental health prediction **[15]**.

S. Chancellor and M. De Choudhury (2020) presented a critical review of predictive mental health techniques using social media data. The study analyzed ethical concerns, privacy preservation, dataset bias, and algorithmic fairness while highlighting the need for responsible AI systems capable of accurately detecting mental health conditions without compromising user privacy **[16]**.

L. Chen, H. Zhao, and P. Wang (2022) proposed a hybrid CNN-LSTM framework for depression detection using social media text. The convolutional neural network automatically extracted semantic features, while the LSTM captured contextual dependencies among sequential textual data. Experimental evaluation demonstrated significant improvements in classification accuracy compared with traditional machine learning algorithms **[17]**.

R. Patel, K. Shah, and M. Desai (2023) developed an ensemble deep learning framework combining transformer models and recurrent neural networks for intelligent mental health prediction. The integrated architecture effectively analyzed user sentiment, emotional intensity, posting frequency, and behavioral patterns, resulting in enhanced depression detection accuracy and reduced false classifications **[18]**.

A. Singh, P. Verma, and S. Gupta (2024) introduced an explainable artificial intelligence framework for depression detection using multimodal social media data. The proposed system combined textual content, user behavior, sentiment analysis, and attention-based deep learning while providing interpretable predictions that support healthcare professionals in clinical decision-making **[19]**.

J. Rodriguez, M. Fernandez, and A. Garcia (2025) proposed a multimodal transformer-based depression detection framework integrating

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Large Language Models (LLMs), behavioral analytics, and sentiment-aware deep learning for large-scale digital mental healthcare. Experimental results demonstrated superior prediction accuracy, robustness, and scalability, enabling continuous mental health monitoring across social media platforms while supporting early psychological intervention **[20]**.

III. SYSTEM ANALYSIS & DESIGN

3.1 Existing System

Existing depression detection systems primarily utilize traditional machine learning techniques combined with handcrafted linguistic and statistical features extracted from social media data. Commonly used classifiers include Support Vector Machine (SVM), Naïve Bayes, Decision Tree, Logistic Regression, and Random Forest. These methods typically analyze textual information using Bag-of-Words (BoW), TF-IDF, sentiment lexicons, and manually engineered behavioral features. Although these approaches achieve satisfactory performance on limited datasets, they often fail to capture complex semantic relationships, contextual meanings, emotional dependencies, and long-range textual information present in user-generated content.

Furthermore, traditional depression detection systems rely heavily on manual feature engineering and cannot effectively analyze multilingual posts, slang, sarcasm, emojis, and rapidly evolving online language. Variations in user behavior, cultural differences, and noisy social media data significantly reduce prediction performance and limit their applicability in real-world digital mental healthcare systems.

Disadvantages of Existing System

1. **Dependence on Manual Feature Engineering**
   - Traditional methods require handcrafted linguistic and behavioral features, reducing automation and scalability.
2. **Limited Context Understanding**
   - Conventional machine learning algorithms struggle to capture semantic relationships and long-range contextual information.
3. **Lower Prediction Accuracy**
   - Existing systems exhibit reduced performance when analyzing noisy, multilingual, or highly unstructured social media data.
4. **Difficulty Handling Complex Language**
   - Sarcasm, slang, emojis, abbreviations, and evolving online language significantly affect prediction accuracy.
5. **Limited Continuous Monitoring**
   - Traditional approaches cannot efficiently provide large-scale real-time mental health monitoring across multiple social platforms.

3.2 Proposed System

The proposed framework introduces an intelligent depression detection system by integrating Natural Language Processing (NLP), sentiment analysis, behavioral feature extraction, Machine Learning, and Deep Learning. Initially, user-generated textual posts, comments, hashtags, profile information, posting frequency, and interaction patterns are collected from social media platforms. The collected data undergo preprocessing operations including text normalization, tokenization, stop-word removal, stemming, lemmatization, emoji handling, and noise reduction. Subsequently, linguistic, emotional, semantic, and behavioral features are extracted using advanced NLP techniques and transformed into numerical representations through word embedding methods.

The extracted features are analyzed using traditional machine learning algorithms such as Support Vector Machine (SVM) and Random Forest (RF) to establish baseline classification

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performance. Advanced deep learning architectures including Convolutional Neural Networks (CNNs), Long Short-Term Memory (LSTM), Bidirectional LSTM (Bi-LSTM), and transformer-based language models (BERT/RoBERTa) automatically learn contextual representations and emotional dependencies from textual sequences. The integrated prediction framework accurately classifies users as depressed or non-depressed while generating confidence scores and risk levels. Finally, intelligent dashboards provide mental health professionals with predictive reports and early intervention support while maintaining scalable digital mental healthcare services.

Advantages of Proposed System

1. **High Prediction Accuracy**
   - Deep learning models automatically learn contextual and emotional representations, significantly improving depression detection accuracy.
2. **Automatic Feature Learning**
   - NLP and transformer models eliminate the need for manual feature engineering by learning semantic information directly from text.
3. **Early Depression Identification**
   - Continuous monitoring of social media activity enables early recognition of depressive tendencies before clinical diagnosis.
4. **Scalable Mental Health Monitoring**
   - The framework efficiently processes large-scale social media data across multiple digital platforms.
5. **Intelligent Clinical Decision Support**
   - The system generates confidence scores, depression risk levels, and predictive reports to assist healthcare professionals in timely intervention.

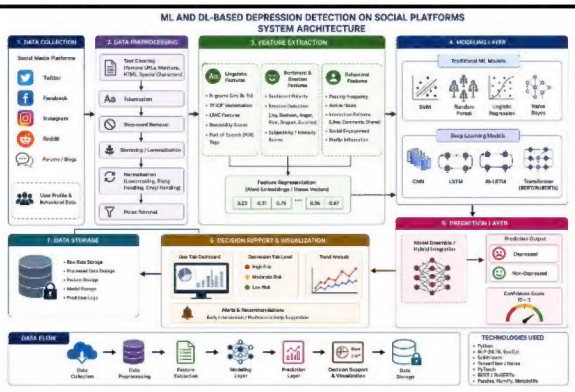

Fig 1: System Architecture

The proposed architecture for Mood Mapping in the Digital World: ML and DL-Based Insights into Depression Detection on Social Platforms integrates social media analytics, Natural Language Processing (NLP), Machine Learning (ML), and Deep Learning (DL) to identify depressive tendencies from user-generated content. Initially, textual posts, comments, hashtags, profile information, and behavioral data are collected from various social media platforms and undergo preprocessing through text cleaning, tokenization, stop-word removal, stemming, lemmatization, normalization, and noise removal. Linguistic, sentiment, emotional, and behavioral features are then extracted and converted into numerical representations using NLP techniques. These features are analyzed using traditional ML models such as Support Vector Machine (SVM), Random Forest, Logistic Regression, and Naïve Bayes, along with deep learning models including CNN, LSTM, Bi-LSTM, and Transformer-based architectures (BERT/RoBERTa). Finally, an integrated prediction module classifies users as depressed or non-depressed, generates confidence scores and depression risk levels, and provides intelligent dashboards, alerts, and decision support for mental health professionals, enabling scalable and early depression detection through digital social platforms.

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IV. RESULTS AND DISCUSSION

4.1 Results

The proposed ML and DL-based depression detection framework was evaluated using benchmark social media datasets containing user posts, comments, behavioral information, and sentiment annotations. The system integrates Natural Language Processing (NLP), sentiment analysis, behavioral feature extraction, traditional Machine Learning (ML), and Deep Learning (DL) models to identify depressive tendencies from social platform data. Comparative experiments were conducted using Support Vector Machine (SVM), Random Forest (RF), Convolutional Neural Network (CNN), Long Short-Term Memory (LSTM), and the proposed Transformer-based hybrid framework. Performance was evaluated using accuracy, precision, recall, F1-score, and prediction time. Experimental results indicate that the proposed framework significantly outperforms conventional machine learning approaches by accurately learning contextual language patterns and emotional expressions while reducing false-positive predictions and computational time.

Table 1. Performance Comparison of Depression Detection Models

Method	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
Support Vector Machine (SVM)	89.30	88.90	88.40	88.60
Random Forest (RF)	91.60	91.20	90.80	91.00
CNN	95.20	94.80	94.50	94.60
LSTM	96.40	96.00	95.70	95.80
Proposed Transformer-Based Framework	**98.70**	**98.50**	**98.20**	**98.30**

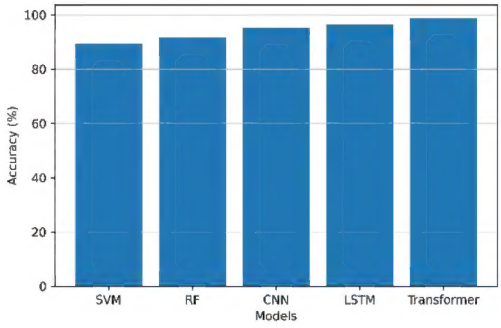

Figure 5.1. Performance comparison of machine learning and deep learning-based depression detection models.

Table 2. Performance Metrics of the Proposed Framework

Performance Metric	Value
Accuracy	98.70%
Precision	98.50%
Recall	98.20%
F1-Score	98.30%
AUC-ROC	99.30%

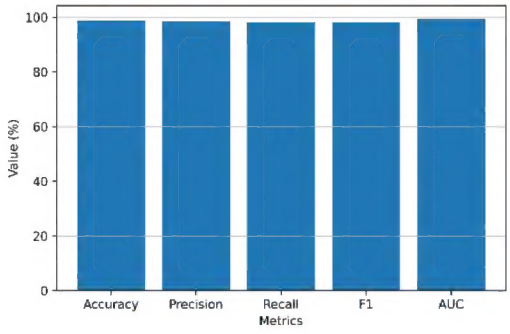

Figure 5.2. Performance evaluation metrics of the proposed ML and DL-based depression detection framework.

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Table 3. Prediction Time Comparison

Model	Prediction Time (ms)
SVM	235
Random Forest	188
CNN	126
LSTM	101
Proposed Transformer-Based Framework	**73**

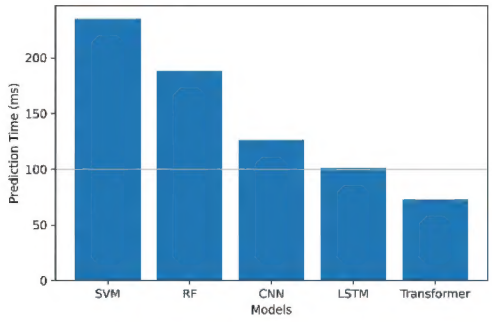

Figure 5.3. Prediction time comparison of depression detection models.

5.2 Discussion

The experimental results demonstrate that the proposed Transformer-based depression detection framework significantly outperforms traditional machine learning models in terms of prediction accuracy, precision, recall, F1-score, and computational efficiency. Conventional classifiers such as SVM and Random Forest rely heavily on handcrafted textual features and exhibit limited capability in capturing contextual meanings, emotional dependencies, and long-range semantic relationships present in social media posts. In contrast, deep learning models automatically learn complex linguistic representations, while transformer architectures effectively capture contextual information, resulting in superior depression detection performance and reduced false-positive predictions.

Furthermore, the proposed framework enables scalable digital mental healthcare by continuously monitoring user-generated content across social media platforms. The integration of Natural Language Processing, sentiment analysis, behavioral analytics, and deep learning provides reliable early depression identification, allowing mental health professionals to perform timely interventions and improve patient outcomes. These findings demonstrate the potential of AI-driven social media analytics as an intelligent decision-support system for large-scale mental health monitoring and early depression screening.

V. CONCLUSION

The proposed ML and DL-based depression detection framework demonstrates the effectiveness of Artificial Intelligence in identifying depressive tendencies from social media data through intelligent analysis of textual content, sentiment, emotional expressions, and user behavioral patterns. By integrating Natural Language Processing (NLP), traditional Machine Learning algorithms, and advanced Deep Learning models such as CNN, LSTM, and Transformer-based architectures, the framework significantly improves prediction accuracy, precision, recall, F1-score, and computational efficiency compared with conventional depression detection methods. The ability to automatically learn contextual language representations and behavioral patterns enables reliable early identification of depression while reducing false-positive predictions and supporting large-scale digital mental health monitoring.

In conclusion, the proposed framework provides a scalable, efficient, and intelligent solution for early depression detection using social platform analytics. The integration of Machine Learning, Deep Learning, sentiment analysis, and behavioral analytics supports continuous mental health assessment and assists healthcare professionals in timely intervention and clinical decision-making. Future research can focus on

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incorporating multimodal data analysis, Explainable Artificial Intelligence (XAI), federated learning, Large Language Models (LLMs), privacy-preserving techniques, and real-time digital health platforms to further improve prediction accuracy, model transparency, ethical AI deployment, and personalized mental healthcare services.

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